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(54) Abstract Title
Determining position and speed

(57) A moving object 3 transmits a signal 5 as it moves along a course. A number of receivers 2 is distributed around the course. Depending on which receiver receives the signal, and the time at which the signal is received, the object can be located at that time. The change in Doppler shift as the object passes the receiver gives its speed. The object may be a horse, athlete, motorcycle or vehicle on a race track or motorway. The signal may be radio, ultrasonic or the noise of an internal combustion engine.

FIG 1

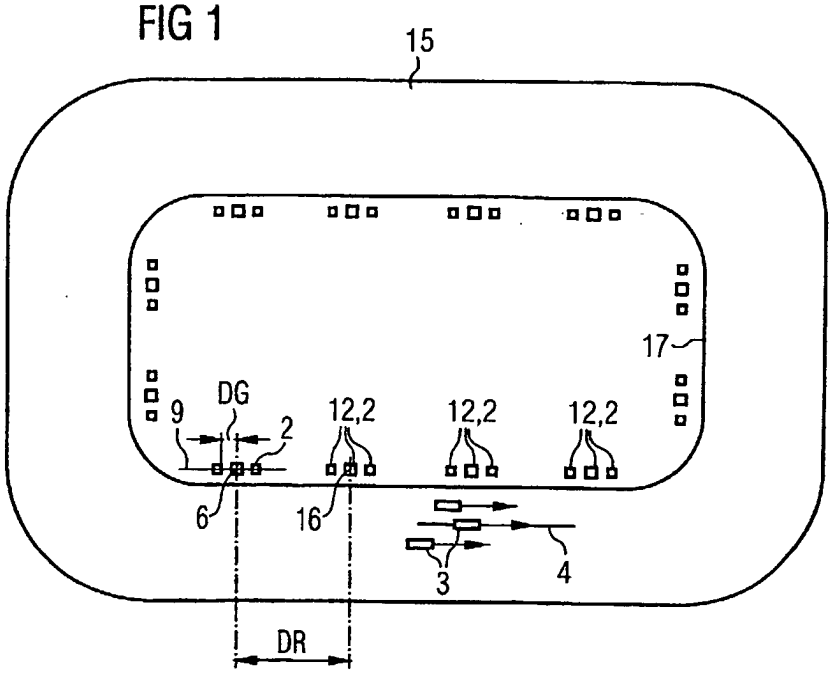

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FIG 1

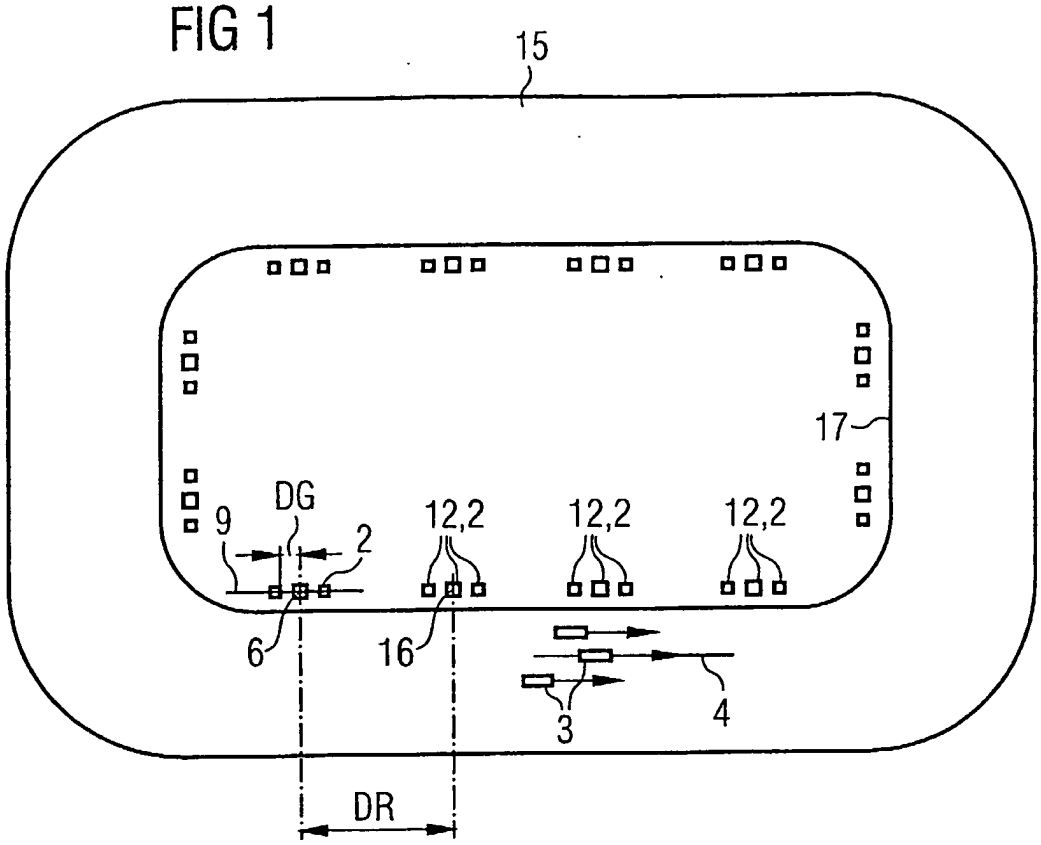

15
17
DG
9
2
12,2
12,2
12,2
6
16
3
4
DR

FIG 2

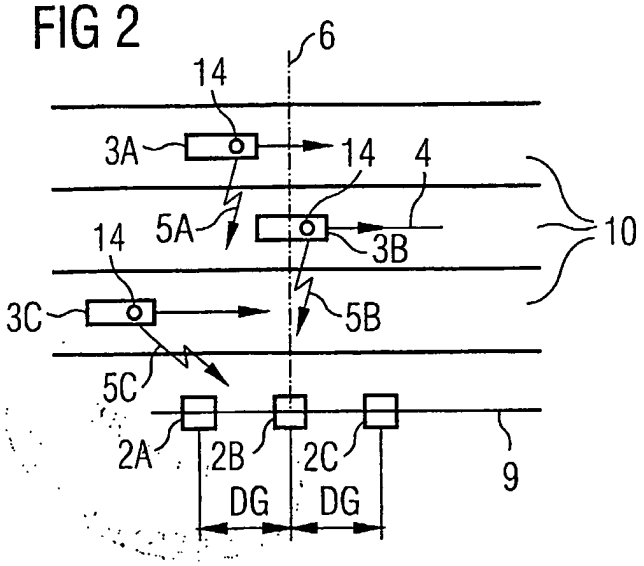

6
14
3A
14
4
14
5A
3B
10
3C
5B
5C
2A
2B
2C
9
DG
DG

FIG 3

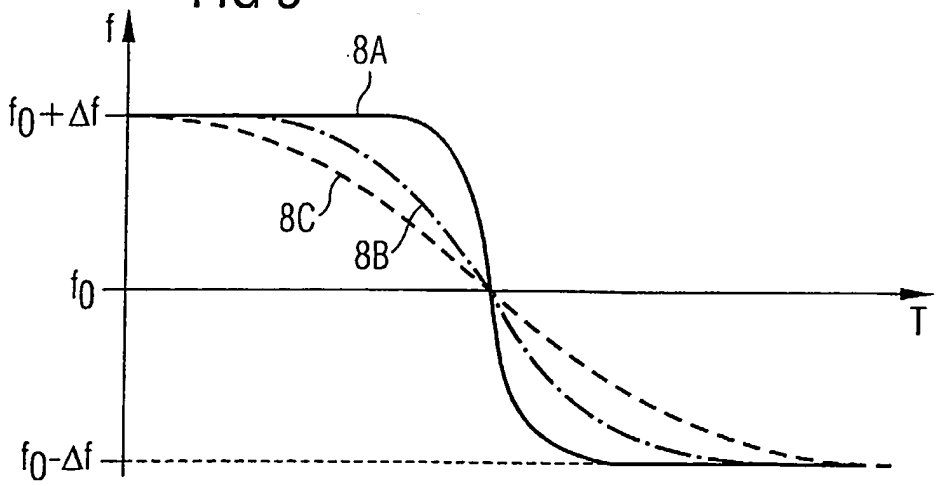


FIG 4

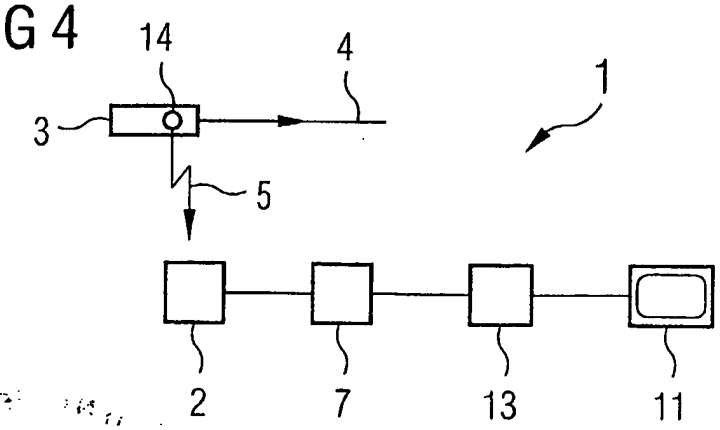
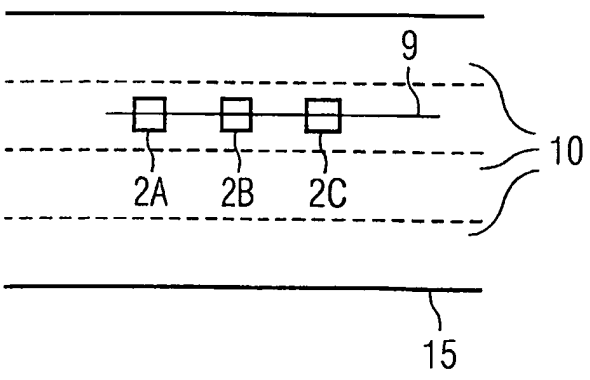


FIG 5



2376585

SYSTEM AND METHOD FOR DETERMINING THE POSITION AND/OR SPEED OF A MOVING OBJECT

TECHNICAL FIELD

The invention relates to systems and methods of determining the position and/or location of a moving object utilising the Doppler effect.

BACKGROUND OF THE INVENTION

Several techniques are known to determine the position or the speed of a moving object like a flying ball, a motor car or a swimmer.

In US-Patent 6,157,898 to Marnelli an active device for measuring a movable object is described. This movable object, such as a baseball, football, hockey puck, soccer ball, tennis ball, bowling ball, or a golf ball includes in its interior a complex electronic circuit. This part of the device, called the object unit, is embedded, secured, or attached to the movable object of interest, and consists of an accelerometer network, electronic processor circuit, and a radio transmitter. Another other part of the device, called the monitor unit, is held or worn by the user and serves as the user interface for the device. The monitor unit has a radio receiver, a processor, an input keypad, and an output display that shows the various motion characteristics measured by the complex internal electrical circuit of the movable object, such as the distance, time of flight, speed, trajectory height, spin rate, or curve of the movable object, and allows the user to input data to the device.

In each of US-Patents 5,481,268 to Higgins, 6,008,752 to Husk at al. and 4,941,638 to Milner an active radar system using the Doppler effect is described. These systems, also known as speedometer providing a sound signal at a first frequency, receiving a second signal which is the reflection of the first signal, and determining difference in frequency between the first and second signals created by the Doppler Effect for calculating the speed of the vehicle.

In US-Patent 5,136,621 to Mitchell et al. describes a timing and lap counting device for a swimmer. This device includes a waterproof housing, which has upwardly projecting digital displays to be viewed by the swimmer and two spaced ultrasonic receivers. The swimmer wears an ultrasonic transmitter tuned to ultrasonic receivers. By measuring the time differential for the ultrasonic signals from the transmitter to reach the receivers in the housing, the position of the swimmer (i.e., in front of, directly over, or behind the housing), is determined. This method of determining the position of the moving object solely relies on the measurement of the difference in two times at which times a signal is detected by two spaced apart receivers.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide a novel system for determining the position and/or the speed of a moving object. With the forgoing and other objects in view there is provided, in accordance with the invention, a system for determining the position and/or the speed of the moving object transmitting a signal and moving almost along a main direction comprising, at least one receiver for receiving the signal, wherein the receiver is at rest and located at a first location and further comprising a processing device for determining the time when the object passes the receiver and/or determining the speed with which the object passes the receiver by using the Doppler profile of the signal.

The technique for determining the position and/or the speed of the moving object involves measuring the Doppler profile of a signal transmitted from the moving object. The signal could be a noise, for example the sound of a motor, the rolling noise of tyres or wheels of a train or it could be a deliberate signal emitted by a transmitter mounted on or connected to the moving object. When the object is approaching or receding from the sensor, and its distance is many times the point of nearest approach to the receiver- also called the sensor in the following-, the asymptote of the Doppler shift will give the amount of the frequency shift. From the Doppler shift according to the known equations of the Doppler effect the velocity of the object passing the receiver can be obtained. The receiver may comprise any suitable sensor or the like which is capable of receiving and identifying the signal

transmitted from the object. The nearest approach to the receiver (nearest distance between the moving object and the receiver) is – by constant speed of the object – determined as the point where the slope of the Doppler profile changes sign. In this way the system also gives the time at which the object passes the receiver, which means the time at which the distance between moving object and receiver is smallest. In other words the instance of passing the receiver will be when the frequency is midway between the approaching and receding values. The rate of transition from approaching to receding frequencies will give the perpendicular distance of the moving object from the sensor which gives the position of the moving object across the path of movement, for example a track. The moving object may move on ground on the earth or may move in the air a short distance away from ground.

By using the Doppler profile or Doppler plot, it is not necessary to know the absolute frequency of the signal transmitted from the moving object very accurately. So it is also possible with the system to determine the position and/or speed of a moving object which emits a signal or many signals without knowing the frequency of the signal. So the system also applies for objects emitting noise. A certain sufficient stability of the signal in frequency is only required for the few moments, in particular a few seconds, that the object passes the receiver.

In accordance with another feature the systems comprises at least two of the receivers located adjacent to each other and grouped around the first location, wherein the two receivers are positioned along a line. Using two or more receivers positioned in a vicinity of the first location makes it possible to make corrections due to any acceleration or deceleration of the moving object. Comparing the Doppler profile received by the at least two receivers makes it furthermore possible to detect and consider a movement of the moving object lateral to the line on which the receivers are positioned. Furthermore by using two or more receivers a compensation of frequency instability can be obtained. When arranging a plurality of receivers reasonably frequently, for example along a race track, it will be possible to determine the position and the progress of moving objects between the at least two receivers and to determine their speed.

In accordance with a further feature the receivers grouped together are positioned on a line, which is non-perpendicular to the main direction of movement of the moving object. In particular the line in parallel or inclined under a small angle to the main direction.

In accordance with an added feature the at least two receivers are spaced apart from each other by a group distance. This group distance lies between 5m and 20 m; in particular is about 10 meters. With these sensors spaced apart of about 10 meters any in particular smooth acceleration or deceleration of the object can be detected. The detection of acceleration and deceleration may also be achieved by using sensors on opposite sides of the path in which the object moves.

In accordance with an additional feature at least another receiver or a group of receivers is located at a second location which is a receiver distance away from the first location. This receiver distance is preferably in the range between 50 m and 300 m, in particular it is about 150 m to 200 m. By using two receivers or two groups of receivers which are spaced apart a long distance also a compensation for frequency instability of the transmitted signal can be achieved. Using a second and even more receivers provides the position of the moving object accurately, in particular when the receivers are distributed along a race track.

In accordance with yet another feature the receiver, a group of receivers a second receiver or more receivers spaced along the path of the moving object are situated aside, underneath or above the path (the track) on which the object is moving.

In accordance with yet an added feature the processing device is capable to determine and to distinguish two different signals transmitted by two different objects. This enables the system to determine the time when the objects pass the receiver or group of receivers to monitor the order of the objects in which they pass the receiver. The system is therefore applicable for determining position and/or speed of a number of objects participating in a sport event, like horse racing, dog racing, motor car racing, motor cycle racing, athletic or swimming event, bicycle racing etc. Furthermore it applies for distinguishing between motor cars moving in different lanes and passing the sensor.

In accordance with yet an additional feature the processing device is connected to a display for real time displaying of position and/or speed of the moving object. Transferring the information of position and/or speed to a display for example a TV monitor, a movie screen, a computer monitor or the like any interested person could watch the progress of a competition race, which is in particular interesting for those betting on one of the moving object reaching the finish in a certain order. It is also useful in speed measurement, in particular speed enforcement to monitor which vehicle is moving above a limited speed and so to identify this vehicle with certainty, for example by taking a photograph of the vehicle.

In accordance with a concomitant feature the receiver is for receiving a radio frequency signal. This radio frequency is preferably in the range of 50 MHz – 200 MHz in particular about 100 MHz. Using a radio frequency signal has the advantage that even if the signal is low powered it will still be received by the receiver over some tens of meters to some 100 meters. For example in the case the signal is transmitted from a transmitter attached to a running horse with a speed of 10 m/s a Doppler shift of about $3*10^{-8}$ of the standard frequency f_0 of the emitted signal will be obtained. By way of example the radio frequency emitted by the moving object is 100 MHz and the Doppler frequency shift would be 3 Hz, which is 0.03ppm. In this case a high-resolution receiver is to be used to achieve a sufficiently accurate determination of the position and the speed of the moving object.

In accordance with again another feature the receiver is used for receiving audio frequency signals. Preferably the receiver is for receiving ultrasonic frequency signals in the range of 30 kHz to 80 kHz, in particular about 40 kHz. In this case a low power signal may be detected by a receiver at a range of some tens of meters, in particular at least 30 meters. It would be therefore most preferable to situate the receiver close to the track or path of the moving object. Positioning the receiver or group receivers just aside the path or above or underneath the path would be most preferable. For a moving horse with a speed of 10 m/s the Doppler shift is about 3% of the standard frequency f_0 of the ultrasonic transmitter. In the case of an ultrasonic frequency f_0 of 40 kHz the Doppler frequency shift is about 1300

Hz. So in this case the stability of the transmitter or the resolution of the receiver doesn't need to be as high as in the case of radio frequencies.

In accordance with again an added feature the system serves to determine the progress and/or the order of at least two objects passing the at least one receiver, at the time when the objects pass the receiver. The system is preferably used and positioned at a race track for horse races, dog races, athletic events, motor car races, motor cycles races, cycle race, swimming events or the like. In any such races two or more moving objects have a different nearest approach to the receiver, so that the slope of the Doppler profile is different for each moving object. The nearer the closest approach to the receiver is the more the Doppler profile has the shape of a step profile. The greater the distance of nearest approach from the receiver is, the less curved is the Doppler profile. This also applies for any two or more objects passing the receiver at different distances of the nearest approach.

In accordance with again an additional feature a transmitter (a sender) is attached or mounted to the moving object, wherein the transmitter transmits the signal at a predetermined frequency. So the time when the measured frequency drops below the predetermined frequency (a priori known frequency of the transmitter) indicates the moment at which the transmitter -hence the object- passes the receiver, which makes a real time monitoring possible. The transmitter may be part of a tag which is more or less moveable or fixed relative to the moving object itself.

In accordance with still another feature the processing device serves for speed measurement of vehicles emitting noise by using the Doppler profile of the noise. Autocorrelation methods can be applied to deduce a frequency shift. Vehicles, in particular motor vehicles emit noise through their electrical or combustion motor as well as noises due to the movement on the ground which are due to the tyres or wheels rolling on the ground. In case the vehicle is moving at a constant speed the noise emitted for example from a motor is stable over the time interval the object passes the receiver, so that the received Doppler profile gives an accurate measure for the Doppler shift, which means the speed as well as the time when the moving object passes the receiver can be accurately determined.

In accordance with another object of the invention a passive method for determining the position and/or the speed of the moving object transmitting a signal and moving almost along a main direction is provided comprising the steps of receiving the signal at at least one fixed first location, determining the Doppler profile of the signal at the first location and determining the time when the object passes the first location and/or determining the speed with which the object passes the first location by using the Doppler profile of the signal.

For the passive method all of the advantages and features described for the system and its passive means also hold, in particular the features with respect to the radio or audio frequencies used, the features of grouping receivers and locating receivers on a more far distance as well as the features referring to the use of the method in horse races, speed enforcement or the like. Preferably in the vicinity of the first location the Doppler profile is determined at at least two different locations.

Brief description of the drawings

Figure 1 is a schematically view of a racetrack with receivers located at the inner boundary of the racetrack;

Figure 2 shows 3 lanes in each of which an object moves;

Figure 3 shows schematically a Doppler profile;

Figure 4 is a schematic diagram of a system for determining speed and/or position of a moving object;

Figure 5 shows the arrangement of receivers on a track

Description of the preferred embodiments

In the figures of the drawings, components corresponding to one an other of the respectively shown exemplary embodiments in each case have the same reference numerals. The embodiments shown in the figure are to some extent simplified in order to emphasise certain features of the invention.

Referring now to the figures of the drawings in detail and first, particularly, to figure 1 thereof, there is shown a race track 15, in particular a horse track. The track 15 has an inner boundary 17. Along that inner boundary 17, e.g. beside the race track 15 a plurality of receivers 2, 12 are arranged. The receivers 2,12 are grouped in threes', wherein adjacent receivers of each group are spaced apart a distance DG. Two groups of receivers 2, 12 are spaced apart a receiver distance DR. The race track 15 has two long straights parallel and opposite to each other and two shorter straights which are each connected by an almost quarter-circle track portion to the long straights. On the race track 15 a number of moving objects 3, for example horses, move along a main direction 4 indicated by arrows. In every group of receivers 2 receivers 2A,2B,2C are arranged along a line 9 which is almost parallel to the straight at which they are located, which means they are almost parallel to the main direction 4 of movement of the moving objects 3. A first group of receivers 2 is located at a first location 6 and a second group of receivers 12 is located at a second location 16 which is the receiver distance DR away from the first location 6. Along each straight two or more groups of receivers 2, 12 are placed to monitor the position of the objects along the track 15. By way of example in Fig.1 for one long straight four groups of receivers 2,12, are shown, wherein for every two adjacent group of receivers one group of receivers is deemed to be placed at a first location and the other group of receivers downstream in the main direction is deemed to be placed at a second location.

For a horserace track 15 the long straights may have a length of some hundred meters and the short straights of around 100 meters or less. The group distance DG, which is the distance between adjacent receivers 2 within one group is about 10 meters and the receiver distance DR which is the distance between two different groups of receivers 2, 12 is about 80-120 meters.

In figure 2 three lanes 10 are shown with moving objects 3A, 3B, 3C in each lane 10. Figure 2 represents a situation of moving objects 3 which may occur along the race track 15 shown on figure 1 or on a motorway with three lanes for one direction wherein on each lane 10 a motorway vehicle 3A, 3B, 3C is moving in the main direction 4 respectively. Each of the moving objects 3A, 3B, 3C has a transmitter 14 which transmit a respective

signal 5A, 5B, 5C. The transmitter 14 may be sending a radio frequency or an ultrasonic signal at a predetermined frequency or the transmitter 14 may be a source of noise which is characteristic for the moving object 3, for example noise emitted by a combustion motor. Parallel to the main direction 4 and outside the lanes 10 a group of three receivers 2A, 2B, 2C is located along a line 9. Within this group two adjacent receivers 2A, 2B; 2B, 2C are spaced apart a group distance DG which may be about 10 meters. The receiver 2B is located at a first location 6, which is symbolised by a straight line perpendicular to the main direction 4. Each of the receiver 2A, 2B, 2C receives each of the signals 5A, 5B, 5C emitted by the transmitters 14 of each moving object 3. The signals 5A, 5B, 5C all show a different Doppler profile 8 when passing the receivers 2A, 2B, 2C. In case the transmitters 14 emits a signal of a predetermined frequency f_0 each of the frequencies is preferably significantly different, so that they could be easily distinguished by the receiver 2.

In figure 3 the Doppler profiles 8A, 8B, 8C are illustrated schematically to show the principle curvature of a Doppler profile 8 by way of example only. The Doppler profile 8A, 8B, 8C in frequency is shown over the time T. It is shown the curvature of the Doppler profile 8A, 8B, 8C in dependence of the nearest approach of a moving object 3 to a receiver 2. A sender 14 sends a signal at a frequency f_0 which may be by way of example 40 kHz. If the sender 14 is moved at a speed of about 10 m/s, which would be the speed of a horse running on a horse track 15, the frequency as received by the receiver 2 when the moving object 3 approaches the receiver 2 from a far distance is $f_0 - \Delta f$ which in case of a frequency f_0 of 40 kHz is about 41.3 kHz. The frequency f received by the receiver 2 when the object 3 is moving away from the receiver has a value $f_0 - \Delta f$, which in this example would be 38.7 kHz. The nearer the moving object 3 approaches and passes the receiver 2 the more the Doppler profile 8A has the shape of a step. The further away the moving object 3 passes the receiver 2 the less curved is the Doppler profile 8C. So even in the case of two moving objects 3A,3C emitting a signal at the same frequency but passing the receiver at different nearest approach it is possible to identify the Doppler profile 8A,8C of each of the moving objects 3A,3C. The change of sign of the slope of the Doppler profiles 8A, 8B, 8C is related to the location of the receiver 2. It gives the time when the object passes the receiver 2. Therefore by determining the Doppler profile 8 it is possible to locate a moving object 3 at a certain time. Furthermore the shift Δf in the

Doppler frequency is a measure for the speed of the moving object 3. Therefore by determining the Doppler profile 8 of a moving object 3 it is possible to determine the position and the speed of the moving object.

In Figure 4 the components of a system 1 for determining the position and/or the speed of a moving object 3 are schematically illustrated. The moving object 3 moves with a certain speed along a main direction 4 having a transmitter 14 which emits a signal 5, in particular at a predetermined known frequency. This signal 5 is received by the receiver 2. The receiver 2 comprises a sensor which is capable of detecting the frequency of the signal. Dependent on the frequency, for example a radio frequency of some tenths or hundreds MHz or an ultrasonic frequency of some tenth kHz an appropriate sensor has to be chosen. The receiver 2 transmits the received information to a processing device 7 in which by using the Doppler profile 8 the speed of the moving object 3 and/or the time when the object 3 passes the first location 6 of the receiver 2 is determined. Using more than one receiver in a group of receivers located in the vicinity of the first location 6 and/or taking the received signals from another group of receiver far away into account also lateral movements of the moving object 3 as well as deceleration and acceleration of the moving object 3 can be considered to determine the correct speed and the position of the moving object 3. This information is transmitted from the processing device 7 to a distributor 13, which distributes this information to a display 11. This display may be a TV monitor, a computer monitor connected to the Internet or a movie screen placed on a racetrack for which the moving objects 3 move. So the system 1 can be used to monitor the progress of a race in a real time environment, which gives the spectator the opportunity to accurately know the order of the moving objects. This is in particular useful in and for betting offices.

Figure 5 shows a track 15 with four lanes 10 where in the ground under the surface of one lane a group of three sensors 2A, 2B, 2C are arranged along a straight line 9 parallel to the lane 10. It is of course also possible to install the receivers 2A, 2B, 2C above the lane 10, so that the objects 3 pass underneath the receivers 2A, 2B, 2C.

Although the system has been illustrated by way of example for a more or less elliptic race track on which moving objects like horses, motor cars, motor cycles or athletes move it is

also applicable for determining the speed and the position of other moving objects like trains moving on a train track or motor vehicles, like cars, lorries, bikes, moving on a motorway. So it may also serve for monitoring the speed of vehicles and for speed enforcement. As the system itself acts purely passive by which means that it receives an already existing signal and does not emit a signal itself, it would be invisible in the sense of emitted radiation - either radiation in radio frequency or audio frequency- for the moving object and hence of particular interest in speed enforcement.

CLAIMS

1. System (1) for determining the position and/or the speed of a moving object (3,3A, 3B, 3C) transmitting a signal (5,5A, 5B, 5C) and moving almost along a main direction (4) comprising:
- at least one receiver (2,2A, 2B, 2C) for receiving said signal (5,5A, 5B, 5C), wherein said receiver (2,2A, 2B, 2C) is in rest and located at a first location (6)
- a processing device (7) for determining the time when said object (3,3A, 3B, 3C) passes said receiver (2,2A, 2B, 2C) and/or determining the speed with which said object (3,3A,3B,3C) passes said receiver (2,2A,2B,2C) by using the Doppler profile (8,8A,8B,8C) of said signal (5,5A,5B,5C).

2. System (1) according to claim 1 with at least two of said receiver (2,2A, 2B, 2C) located adjacent to each other and grouped around said first location (6), said at least two receivers (2,2A, 2B, 2C) positioned along a line (9).

3. System (1) according to claim 2 wherein said line (9) is non-perpendicular to said main direction (4), in particular parallel to or inclined under a small angle to said main direction (4).

4. System (1) according to claim 2 or 3 wherein said at least two receivers (2,2A, 2B, 2C) are spaced apart from each other by a group distance (DG).

5. System (1) according to claim 4 wherein said group distance (DG) lies between 5 m and 20 meter, in particular is about 10 m.

6. System (1) according to any of the preceding with at least another receiver (12,12A, 12B, 12C) is located at a second location (16) a receiver distance (DR) away from said at least one receiver (2,2A, 2B, 2C).

7. System (1) according to claim 6, wherein said receiver distance (DR) lies between 50m and 300 m, in particular is about 100m to 150 m.

8. System (1) according to any of the preceding claims wherein said receiver (2,2A, 2B, 2C) is situated aside, underneath or above a track (10) on which said object (3,3A, 3B, 3C) is moving.

9. System (1) according any of the preceding claims wherein said processing device (7) is able to determine and to distinguish two different signals (5,5A, 5B, 5C) transmitted by two different objects (3,3A, 3B, 3C).

10. System (1) according to any of the preceding claims wherein said processing device (7) is connected to a display (11) for real time displaying of position and/or speed of said moving object (3,3A, 3B, 3C).

11. System (1) according to any of the preceding claims wherein said receiver (2,2A, 2B, 2C) is for receiving radio frequency signals.

12. System (1) according to claim 11, wherein said receiver (2,2A, 2B, 2C) is for receiving radio frequency signals in the range of 50MHz to 200 MHz, in particular about 100 MHz.

13. System (1) according to any of claims 1 to 10, wherein said receiver (2,2A, 2B, 2C) is for receiving audio frequency signals.

14. System (1) according to claim 13, wherein said receiver (2,2A, 2B, 2C) is for receiving ultrasonic frequency signals in the range of 30 kHz to 80 kHz, in particular about 40 kHz.

15. System according to any of the preceding claims, wherein the order of at least two objects (3,3A, 3B, 3C) passing said at least one receiver (2,2A, 2B, 2C), when passing said receiver (2,2A, 2B, 2C), is determined.

16. System according to any of the preceding claims, positioned at a race track (15) for horse races, dog races, athletic events, motor car races, motor cycles races or the like.

17. System according to any of the preceding claims, wherein to said moving object (3,3A, 3B, 3C) a transmitter (14) is mounted, which transmits said signal (5,5A, 5B, 5C) at a predetermined frequency.

18. System (1) according to anyone of the claims 1 to 15, wherein said processing device (7) serves for speed measurement of vehicles (3,3A, 3B, 3C) emitting noise by using the Doppler profile (8,8A, 8B, 8C) of said noise.

19. Passive method for determining the position and/or the speed of a moving object (3,3A, 3B, 3C) transmitting a natural signal (5,5A, 5B, 5C) and moving almost along a main direction (4) comprising the steps:
- receiving said signal (5,5A, 5B, 5C) at least one fixed first location (6)
- determining the Doppler profile (8,8A, 8B, 8C) of said signal (5,5A, 5B, 5C) at said first location (6)
– determining the time when said object (3,3A, 3B, 3C) passes said first location (6) and/or determining the speed with which said object (3,3A,3B,3C) passes said first location (6) by using the Doppler profile (8,8A,8B,8C) of said signal (5,5A,5B,5C).

20. Method according to claim 19, wherein in the vicinity of said first location (6) at least two different locations said Doppler profile (8,8A, 8B, 8C) is determined.

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INVESTOR IN PEOPLE

Application No: GB 0114193.6 **Examiner:** Dr E.P. Plummer
Claims searched: 1 (partially) at least **Date of search:** 12 March 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T):

Int Cl (Ed.7):

Other: Online :EPODOC, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	WO89/08301A	CREWS whole document	1 (first option) at least
X	US5696481	PRIVATES INST whole document	1 (first option) at least
X	US5666101	DIGITAL EQUIP whole document	1 (first option) at least
X	US5305201	MATTHEWS whole document	1 (first option) at least
X	US5140307	OMEGA whole document	1 (first option) at least
X	US5130955	LUERKER whole document	1 (first option) at least
X	US4449114	DATASPEED whole document	1 (first option) at least
X	US4142680	OSWALD whole document	1 (first option) at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Application No: GB 0114193.6 **Examiner:** Dr E.P. Plummer
Claims searched: 1 (partially) at least **Date of search:** 12 March 2002

Category	Identity of document and relevant passage		Relevant to claims
X	US3946312	OSWALD whole document	1 (first option) at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.